CLAIMS

What is claimed is:

1. A sputter transport device comprising:

   (a) a sealable, pressure-controlled chamber defining an interior space;

   (b) a target cathode disposed in the chamber;

   (c) a magnetron assembly disposed in the chamber proximate to the target cathode;

   (d) a substrate holder disposed in the chamber and spaced at a distance from the target cathode; and

   (e) a negatively-biased, non-thermionic electron/plasma injector assembly disposed between the target cathode and the substrate holder.

2. The device according to claim 1 comprising a reactive gas supply source fluidly communicating with the chamber.

3. The device according to claim 2 wherein the reactive gas supply source is adapted to supply a gas to the chamber, and the gas includes a component selected from the group consisting of nitrogen, oxygen, and hydrogen.

4. The device according to claim 1 comprising a background gas supply source fluidly communicating with the chamber.

5. The device according to claim 4 wherein the background gas supply source is adapted to supply a gas including argon.

6. The device according to claim 1 wherein the target cathode is negatively biased.

7. The device according to claim 1 wherein the target cathode has a circular configuration.

8. The device according to claim 1 wherein the target cathode has a rectilinear configuration.

9. The device according to claim 1 wherein the target cathode is constructed from a material selected from the group consisting of conducting, semiconducting, and insulating materials.

10. The device according to claim 1 wherein the target cathode has a composition including a Group III material.

11. The device according to claim 10 wherein the Group III material is selected from the group consisting of aluminum, gallium, indium, and binary, ternary, and quaternary alloys and compounds thereof.

12. The device according to claim 1 wherein the target cathode includes zinc.

13. The device according to claim 1 comprising a heat exchanger system adapted to circulate a heat transfer medium to remove heat from the target cathode.

14. The device according to claim 1 comprising a target cathode holder disposed in the chamber, wherein the target cathode is supported by the target cathode holder.

15. The device according to claim 14 wherein the target cathode holder is cup-shaped and the target cathode comprises a liquid-phase component.

16. The device according to claim 15 wherein the target cathode holder is constructed from a material selected from the group consisting of metallic and insulating materials.

17. The device according to claim 15 wherein the target cathode holder is constructed from a component selected from the group consisting of molybdenum and stainless steel.

18. The device according to claim 14 comprising a voltage source communicating with the target cathode holder, wherein the target cathode is negatively biased.

19. The device according to claim 14 comprising a heat exchanger system adapted to circulate a heat transfer medium to remove heat from the target cathode holder.

20. The device according to claim 14 in which the target cathode holder is heated.

21. The device according to claim 1 wherein the magnetron assembly is cooled.

22. The device according to claim 1 wherein the magnetron assembly has a circular configuration.

23. The device according to claim 1 wherein the magnetron assembly has a rectilinear configuration.

24. The device according to claim 1 wherein the magnetron assembly includes a plurality of magnets including a centrally disposed magnet and a radially disposed magnet oppositely poled with respect to the centrally disposed magnet.

25. The device according to claim 1 wherein the magnetron assembly includes a plurality of magnetron magnets arranged in an unbalanced configuration.

26. The device according to claim 1 wherein the substrate holder is negatively biased.

27. The device according to claim 1 wherein the injector assembly is constructed from the same material as the target cathode.

28. The device according to claim 1 wherein the injector assembly is constructed from a material different from the target cathode.

29. The device according to claim 1 wherein the injector assembly has a circular configuration.

30. The device according to claim 1 wherein the injector assembly has a linear configuration.

31. The device according to claim 1 wherein each injector of the injector assembly includes a replaceable nozzle.

32. The device according to claim 31 wherein each nozzle is constructed from the same material as the target cathode.

33. The device according to claim 31 wherein each nozzle is constructed from a material different from the target cathode.

34. The device according to claim 1 comprising an injector assembly holder secured to the injector assembly and adapted to circulate a heat transfer medium to remove heat from the injector assembly.

35. The device according to claim 1 wherein the injector assembly comprises a plurality of hollow cathode injectors disposed in fluid communication with a gas source, each injector including an orifice communicating with the interior space of the chamber

36. The device according to claim 35 wherein the injector assembly comprises:

(a) a main body having a generally annular orientation with respect to a central axis and including a process gas section and a cooling section, the process gas section defining a process gas chamber and the cooling section defining a heat transfer fluid reservoir; and

(b) a plurality of gas nozzles removably disposed in the main body in a radial orientation with respect to the central axis and in heat transferring relation to the heat transfer fluid reservoir, each gas nozzle providing fluid communication between the process gas chamber and a region exterior to the main body.

37. The device according to claim 1 comprising a containment shield and a containment magnet, the containment shield disposed

between the target cathode and the substrate holder and the containment magnet disposed adjacent to the containment shield.

38. The device according to claim 37 wherein the containment shield is negatively biased.

39. The device according to claim 37 wherein the containment shield is constructed from the same material as the target cathode.

40. The device according to claim 37 wherein the containment shield is constructed from a material different from the target cathode.

41. The device according to claim 37 wherein the containment shield is constructed from aluminum.

42. An electron/plasma injector assembly adapted for non-thermionically supplying plasma to a reaction chamber, the injector assembly comprising:

(a) a main body having a generally annular orientation with respect to a central axis and including a process gas section and a cooling section, the process gas section defining a process gas chamber and the cooling section defining a heat transfer fluid reservoir; and

(b) a plurality of gas nozzles removably disposed in the main body in a radial orientation with respect to the central axis

and in heat transferring relation to the heat transfer fluid reservoir, each gas nozzle providing fluid communication between the process gas chamber and a region exterior to the main body.

43. A method for depositing a sputtered material at a high deposition rate comprising the steps of:

(a) providing a negatively-biased target cathode including a target material in a sealed chamber;

(b) providing a substrate holder in the chamber spaced at a distance from the target cathode;

(c) applying an operating voltage to the target cathode to produce an electric field within the chamber;

(d) providing a magnetron assembly in the chamber to produce a magnetic field within the chamber;

(e) providing a negatively-biased, non-thermionic electron/plasma injector assembly between the target cathode and the substrate holder to create an intense plasma proximate to the target cathode;

(f) introducing a gas into the chamber to provide an environment for generating a plasma medium; and

(g) causing a portion of the target material to be sputtered and transported through the plasma medium toward the substrate holder.

44. The method according to claim 43 comprising the step of introducing a reactive gas into the chamber.

45. The method according to claim 43 wherein the injector assembly comprises:

(a) a main body having a generally annular orientation with respect to a central axis and including a process gas section and a cooling section, the process gas section defining a process gas chamber and the cooling section defining a heat transfer fluid reservoir; and

(b) a plurality of gas nozzles removably disposed in the main body in a radial orientation with respect to the central axis and in heat transferring relation to the heat transfer fluid reservoir, each gas nozzle providing fluid communication between the process gas chamber and a region exterior to the main body.

46. A material produced according to the method of claim 43 wherein the material is produced in a bulk form suitable for use as a substrate.

47. A material produced according to the method of claim 43 wherein the material is produced as a thin film deposited on a substrate.

48. A Group III nitride compound produced according to the method of claim 43.

49. The compound according to claim 48 produced at a growth rate ranging from approximately 0.05 μm/min to approximately 10 μm/min.

50. The compound according to claim 48 produced at a growth rate of at least approximately 0.05 μm/min.

51. The compound according to claim 48 produced at a growth rate of at least approximately 1 μm/min.

52. The compound according to claim 48 having a diameter ranging from approximately 1 inch to approximately 8 inches.

53. The compound according to claim 48 having a thickness of at least approximately 1 mm.

54. An oxide compound produced according to the method of claim 48.

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